DOCUMENT-IDENTIFIER: US 6268919 B1
TITLE: System and method for measuring thin film properties and analyzing
two-dimensional histograms using and/not operations

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DEPR:
FIG. 13 is a histogram illustrating the relationship between changes in S
polarized radiation (.DELTA.S.sub.SP) and P polarized radiation (.DELTA.P.sub.SP) with respect to thin film measurements when an angle of
incidence of the radiation source is between 71 degrees and 90 degrees
according to the preferred embodiment of the present invention. This range of
angle of incidence has the highest sensitivity to lubricant thickness change,
specifically the P-polarized light. This embodiment is optimized for measuring
lubricant pooling/depletion. When in this range of angles, the spatial
frequency of the measured surface roughness is nearly twice as large as when
measured at near normal incidence. This allows the measurement of high spatial
frequency roughness (microroughness). The technique used for analyzing these
histograms is similar to the description set forth above. With respect to FIG.
12, since the values of .DELTA.S.sub.SP and .DELTA.P.sub.SP are both positive
for lubricant depletion and carbon wear, one technique for identifying which
occurs is to determine the point at which the slope of the histogram changes,
as illustrated in FIG. 12. The .DELTA.P.sub.SP, .DELTA.S.sub.SP histograms are
constructed by subtracting the reference images (taken before any testing has
begun) from data gathered during the testing procedure (start/stops, thin film
head flying or dragging). The differential images are constructed as described
earlier and the analysis described above is applied to the histograms. A time
sequence of histograms can be constructed by subtracting images at various time

points from the reference images. In this manner the evolution of the
histograms and hence the disk surface can be followed and analyzed.

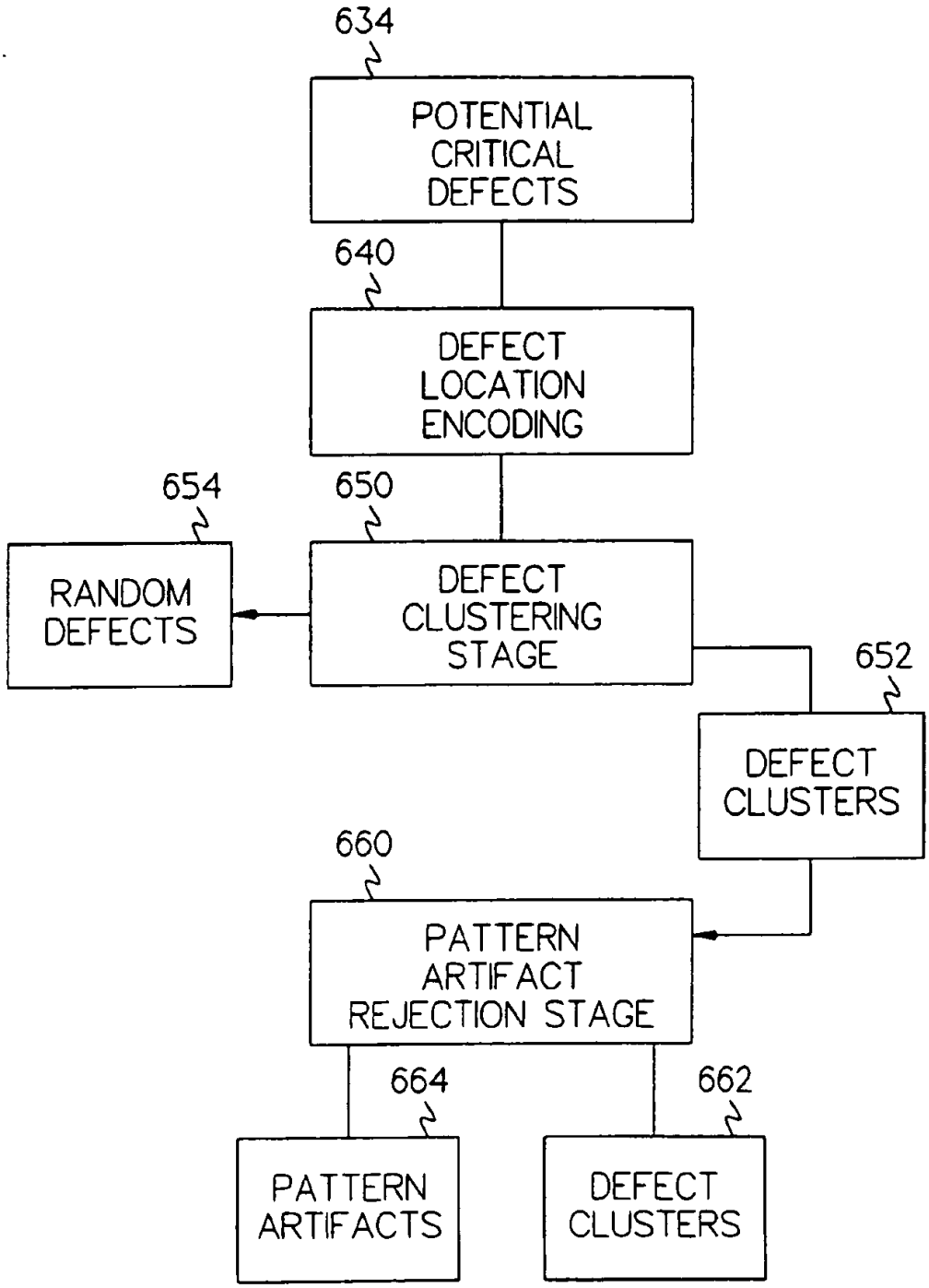

Fig_8

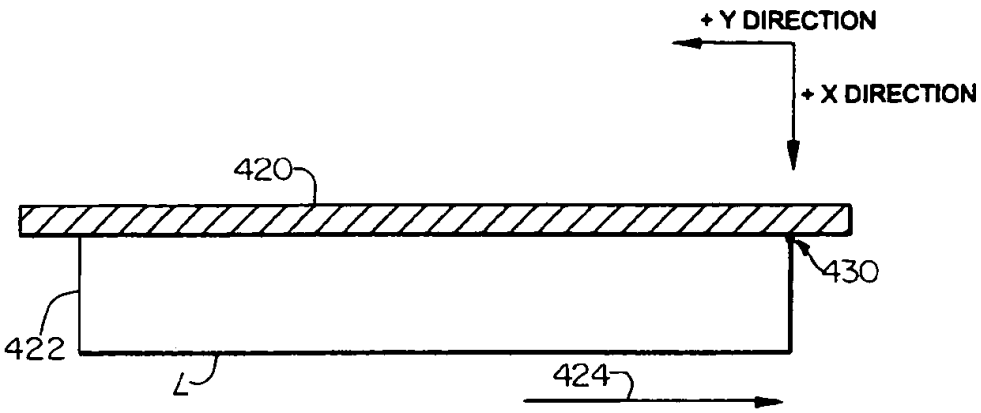
+ Y DIRECTION
+ X DIRECTION
420
430
422
424

FIG. 4

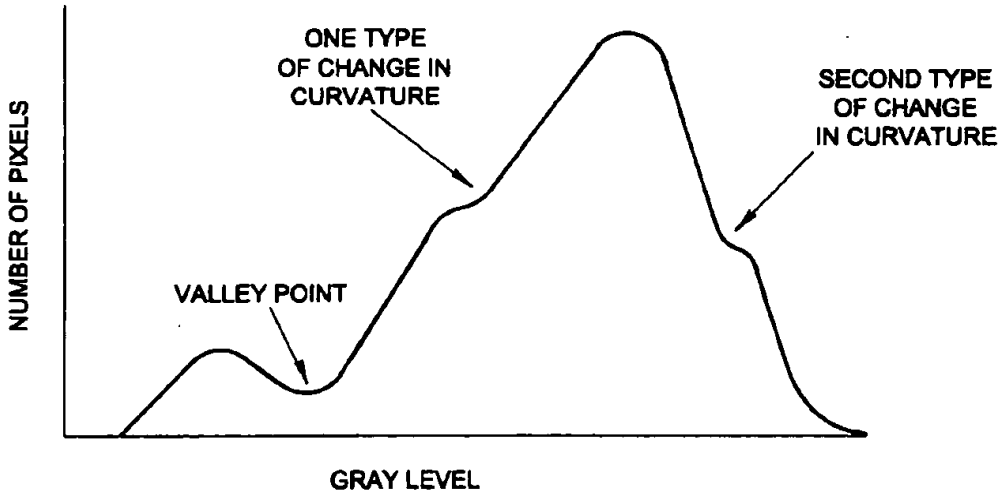
ONE TYPE OF CHANGE IN CURVATURE
SECOND TYPE OF CHANGE IN CURVATURE
VALLEY POINT
NUMBER OF PIXELS
GRAY LEVEL

FIG. 5

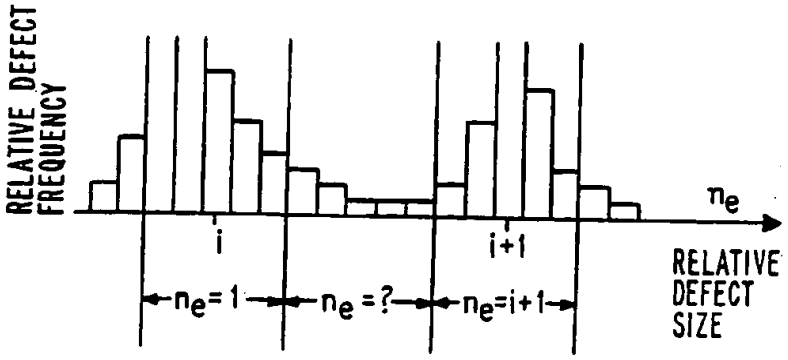

Fig. IIC

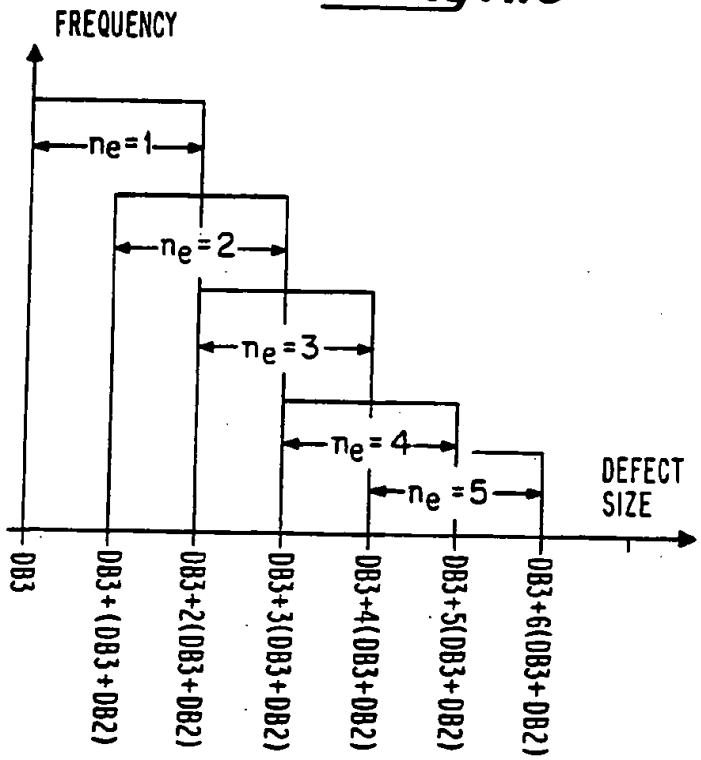

Fig. IID

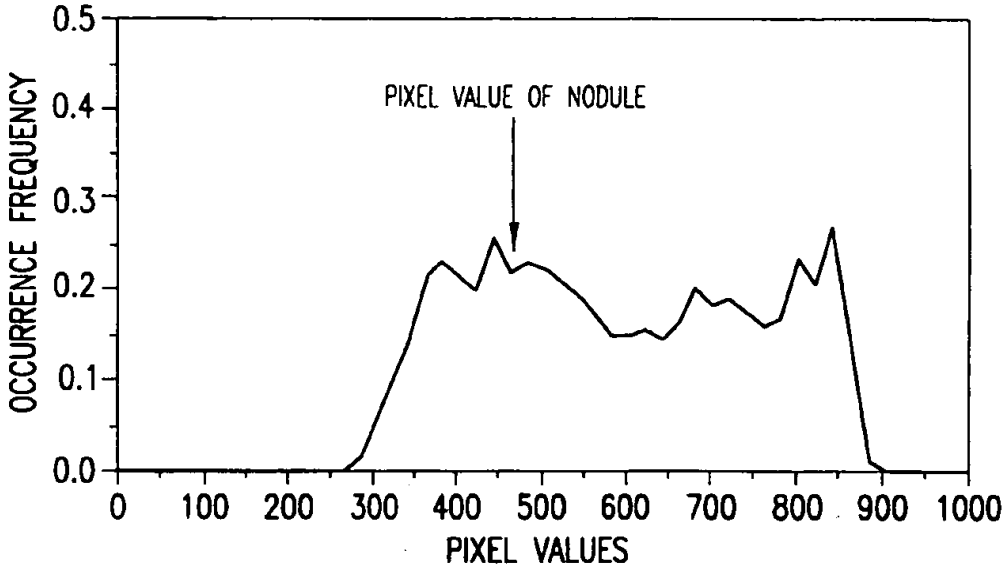
0.5
0.4
0.3
0.2
0.1
0.0
OCCURRENCE FREQUENCY
PIXEL VALUE OF NODULE
0
100
200
300
400
500
600
700
800
900
1000
PIXEL VALUES

FIG. 6A

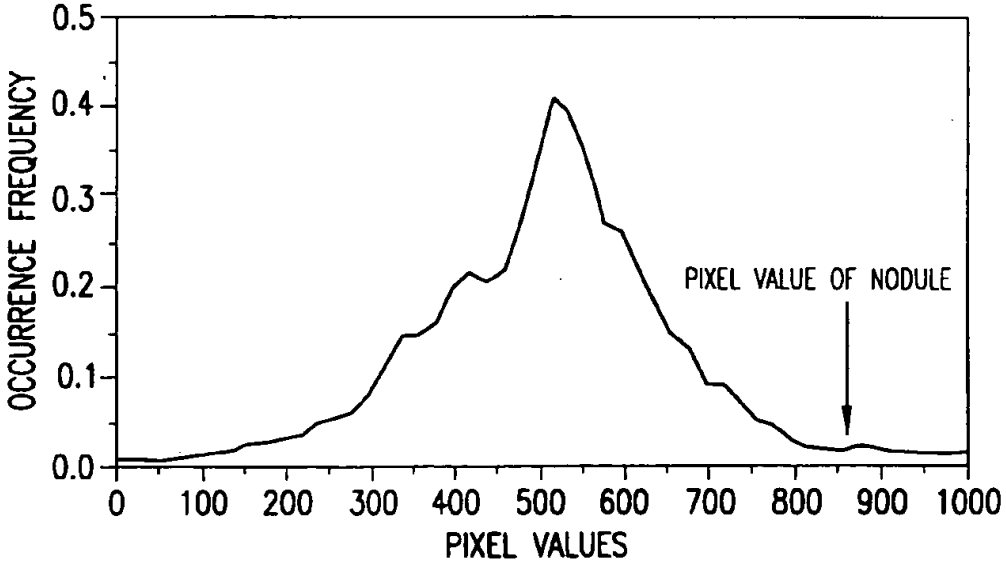
0.5
0.4
0.3
0.2
0.1
0.0
OCCURRENCE FREQUENCY
PIXEL VALUE OF NODULE
0
100
200
300
400
500
600
700
800
900
1000
PIXEL VALUES

FIG. 6B